

April 11-12, 2023

NORTH DAKOTA ASPHALT CONFERENCE

photo credit: Tyler Wilson, Mayo Construction

NORTH DAKOTA
ASPHALT
CONFERENCE
APRIL 11-12, 2023
Bismarck Hotel and Conference Center
800 S. 3rd St. • Bismarck, ND (formerly Radisson)

BETTER STRENGTH

BETTER PAVEMENT

BETTER LIFE

Construction of High Quality Longitudinal Joints

Mark Blow
Sr. Regional Engineer
Asphalt Institute

How many more years, if...?

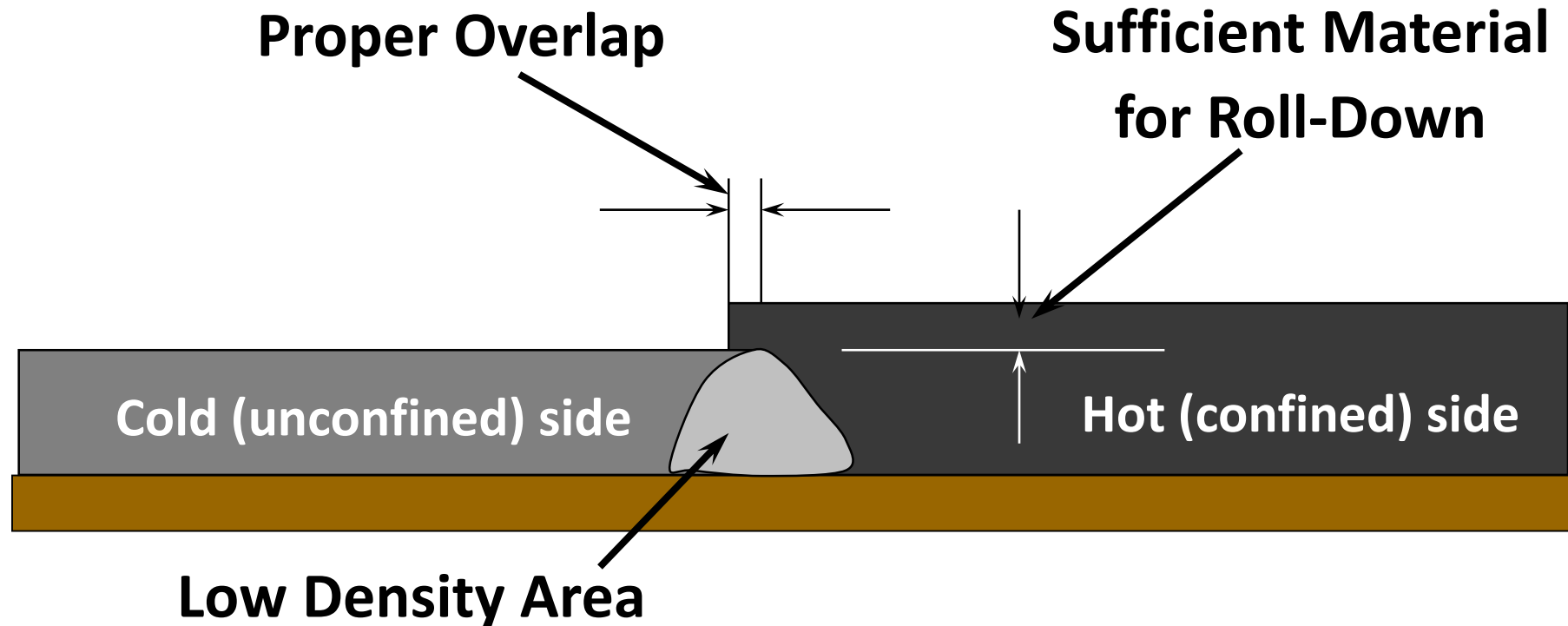


Credit: Jim Trepanier and IL DOT

Paving Longitudinal Joints - Two Goals



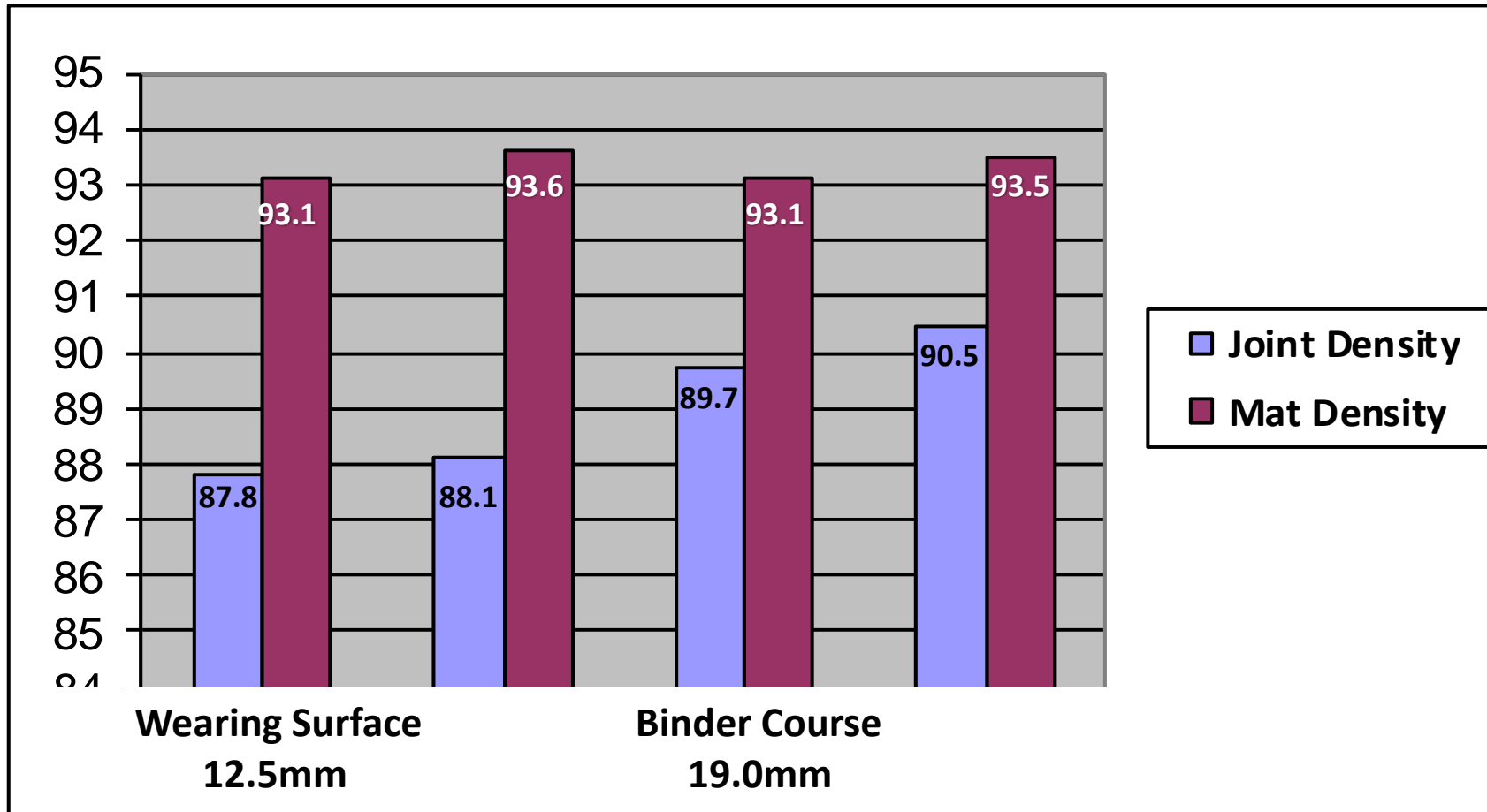
We Know Unsupported Edge Will Have Lower Density



Please note **Cold side** and **Hot side**, as they are terms used throughout this Workshop.

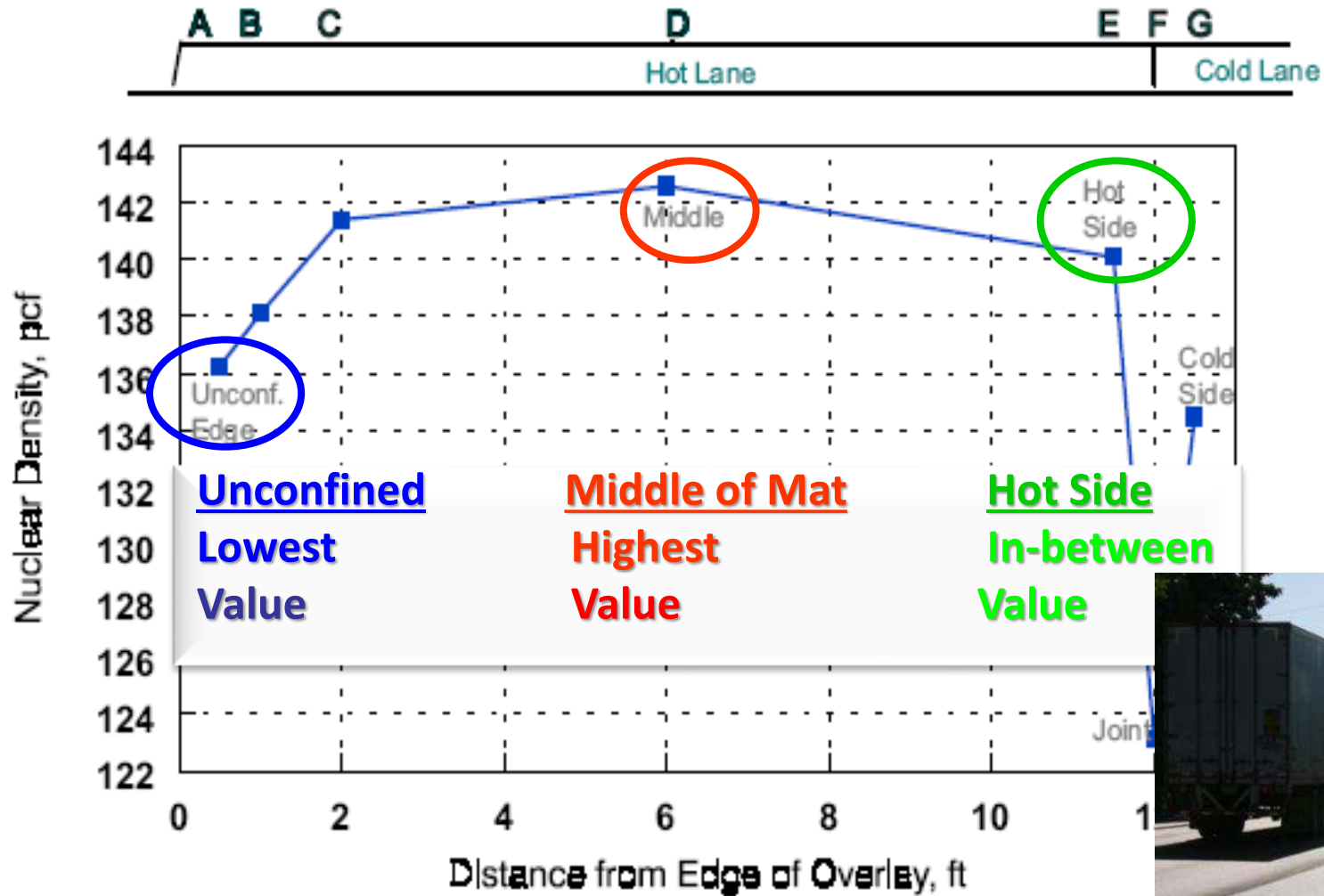
- “It is recommended to specify minimum compaction level at the longitudinal joint (generally 2% lower than that specified for the mat away from the joint).” NCAT / PaDOT, 2002
- “Maximum of 2% less than the corresponding mat density and minimum of 90% of TMD at the specific location.” Nevada, 2004
- “The evaluation is considered failing if the joint density is more than 3.0 pcf below the density taken at the core random sample location and the correlated joint density is less than 90%.” TTI, 2006
- “Joint density, 2% less than mat density, is achievable when measured with cores.” NCAT, 2007

Joint vs. Mat Density



2006-2007, with 6" cores⁶ taken over joint

Typical Nuclear Density Profile



Low Density creates high permeability



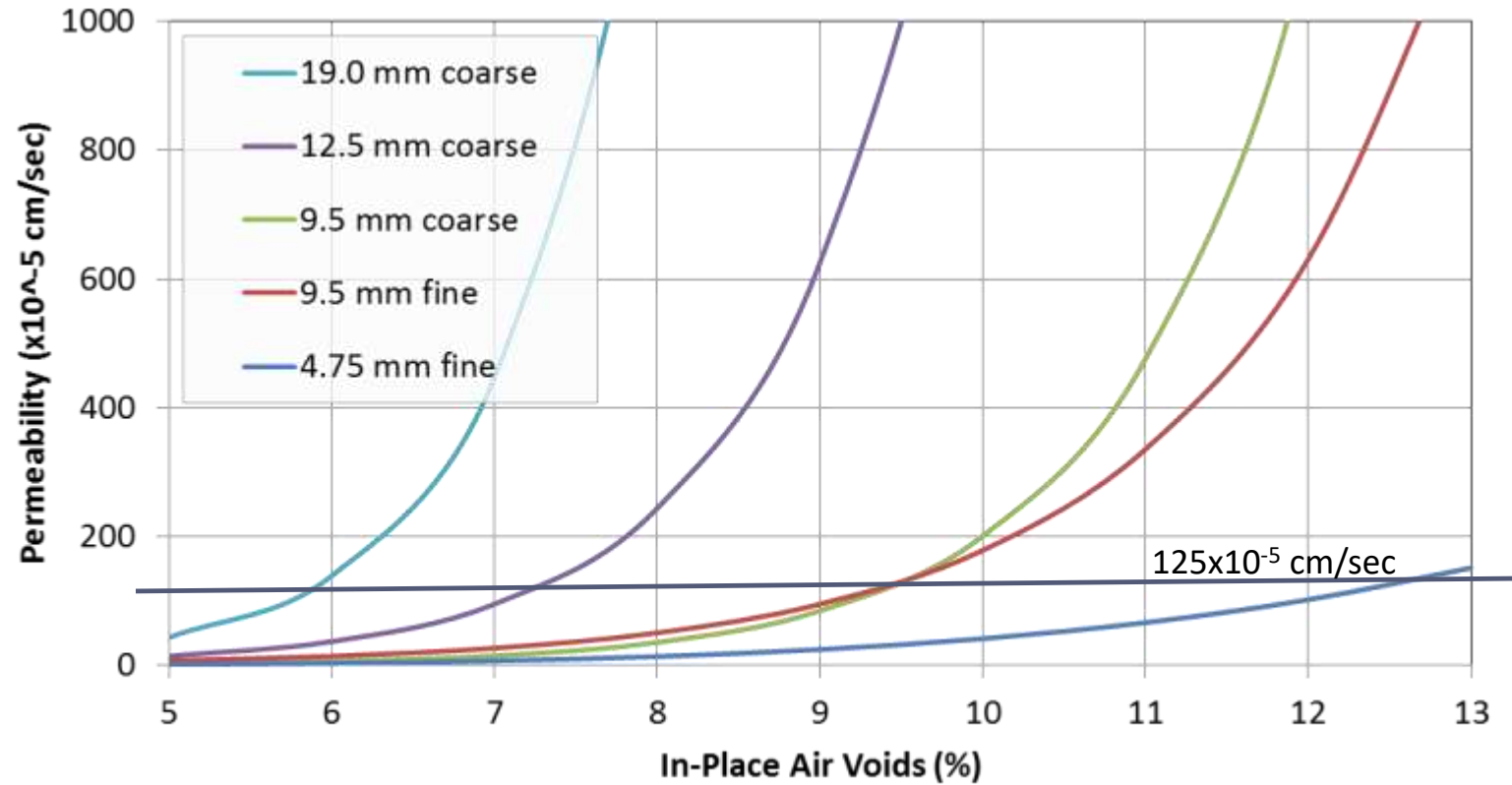
Photo: Wes McNett

**Permeability
at the
Longitudinal
Joint**

High Permeability can be Catastrophic

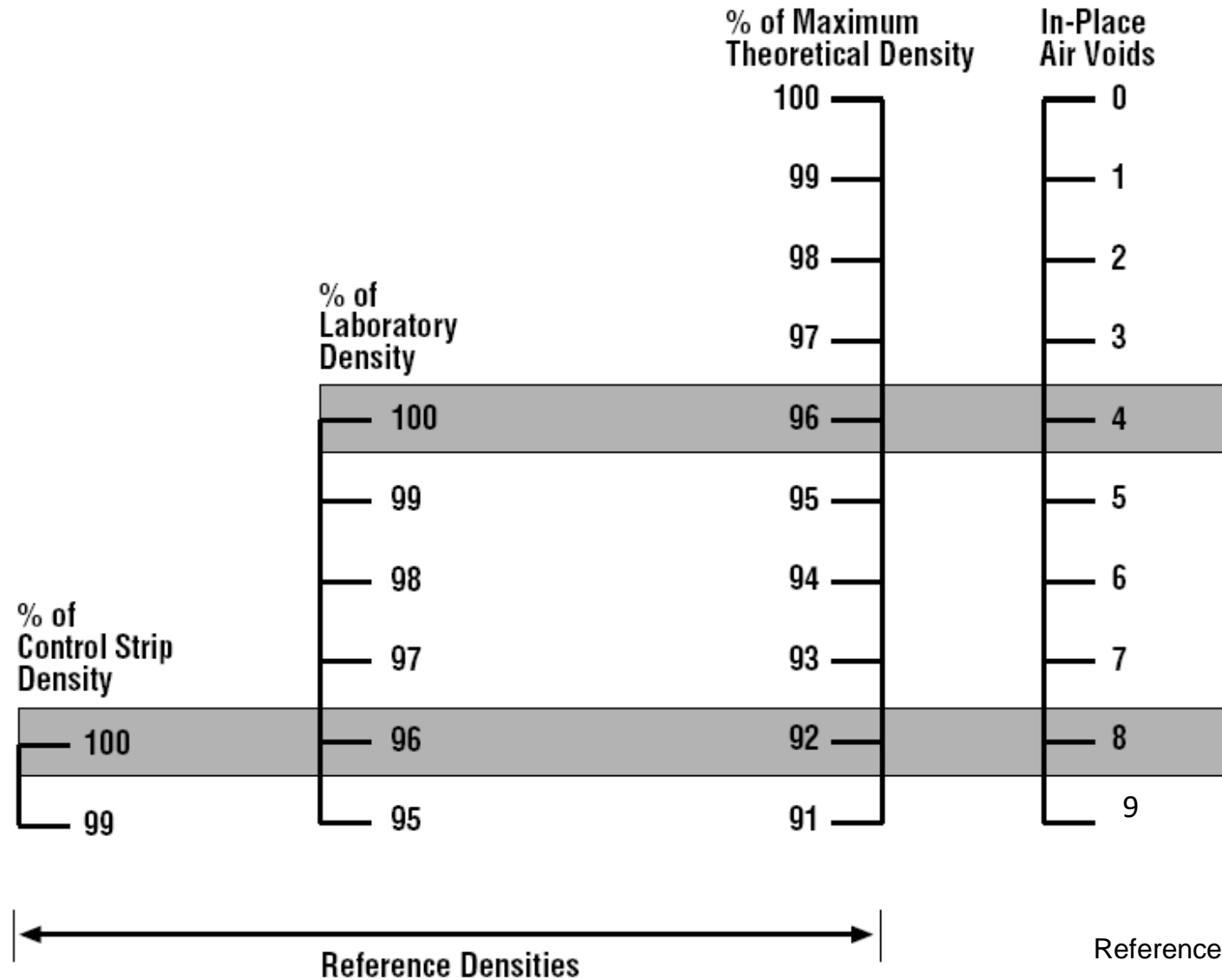


NCAT Permeability Study



Finer NMAS mixes are less permeable at equivalent air void levels!

Reference Densities



Reference MS-22, Fig. 7.09

Improved Compaction = Improved Performance

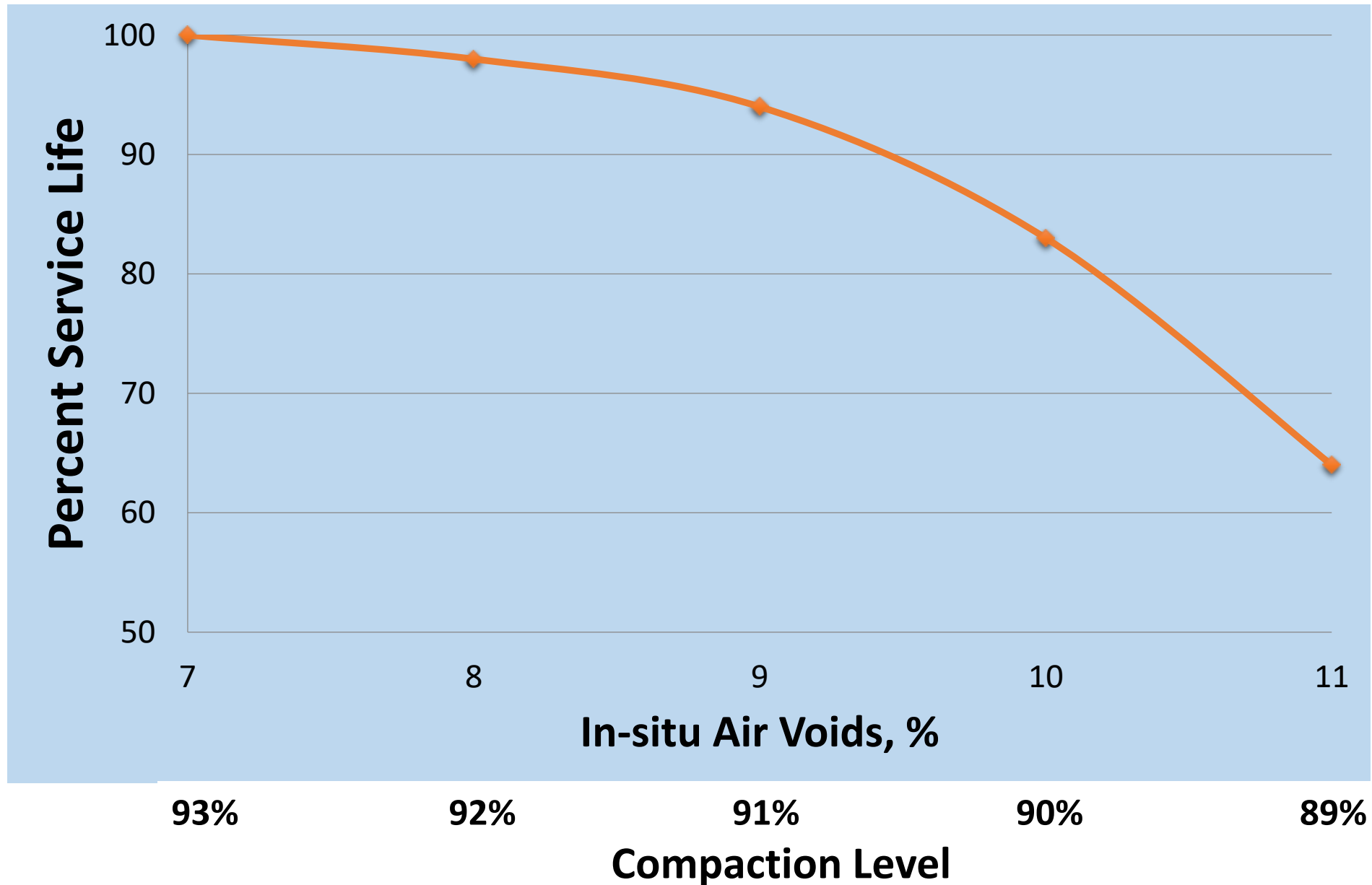
A **BAD** mix with **GOOD** density out-performed a **GOOD** mix with **POOR** density for ride and rutting.



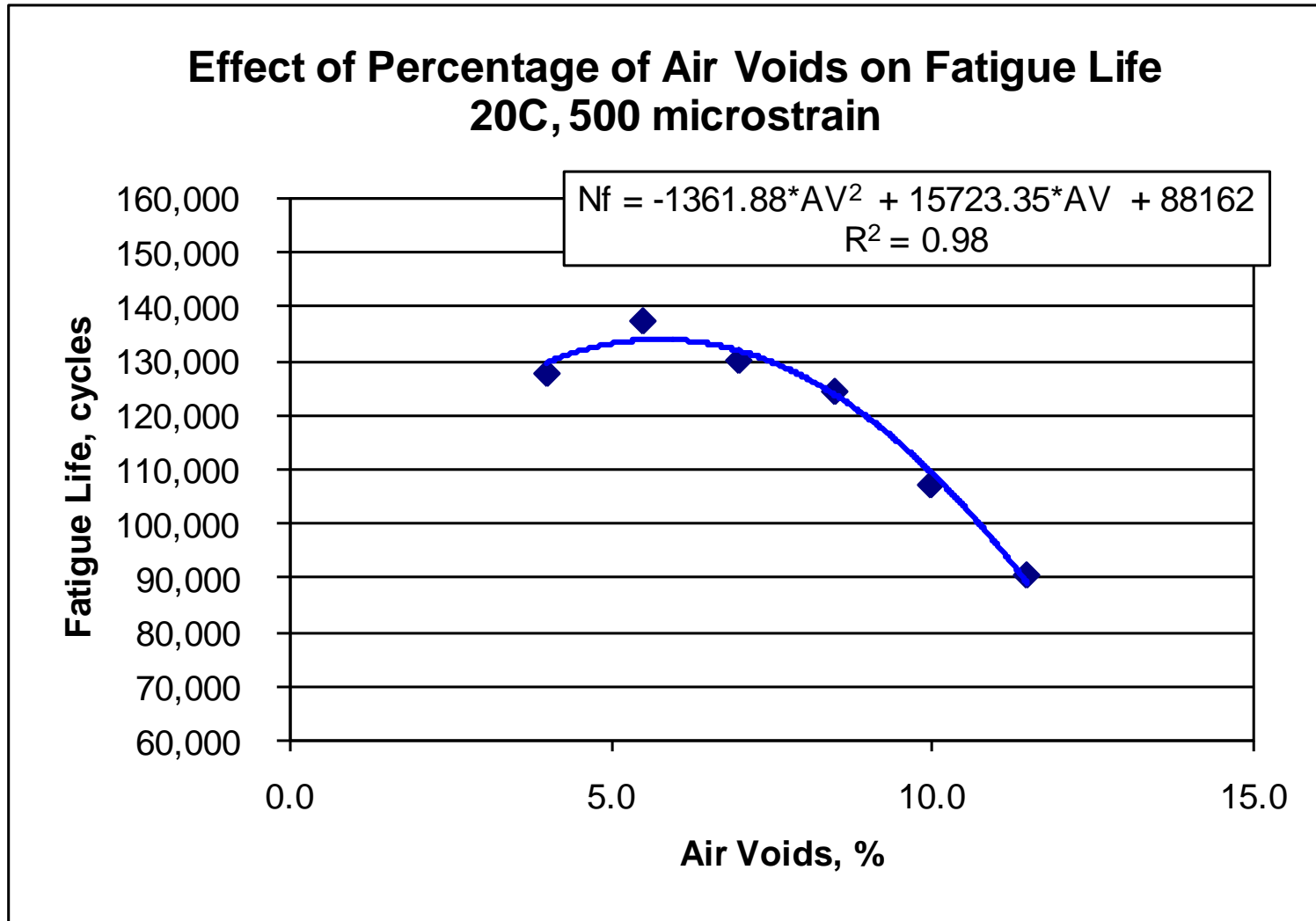
WesTrack Experiment

Effect of In-Place Voids on Life

Washington State DOT Study



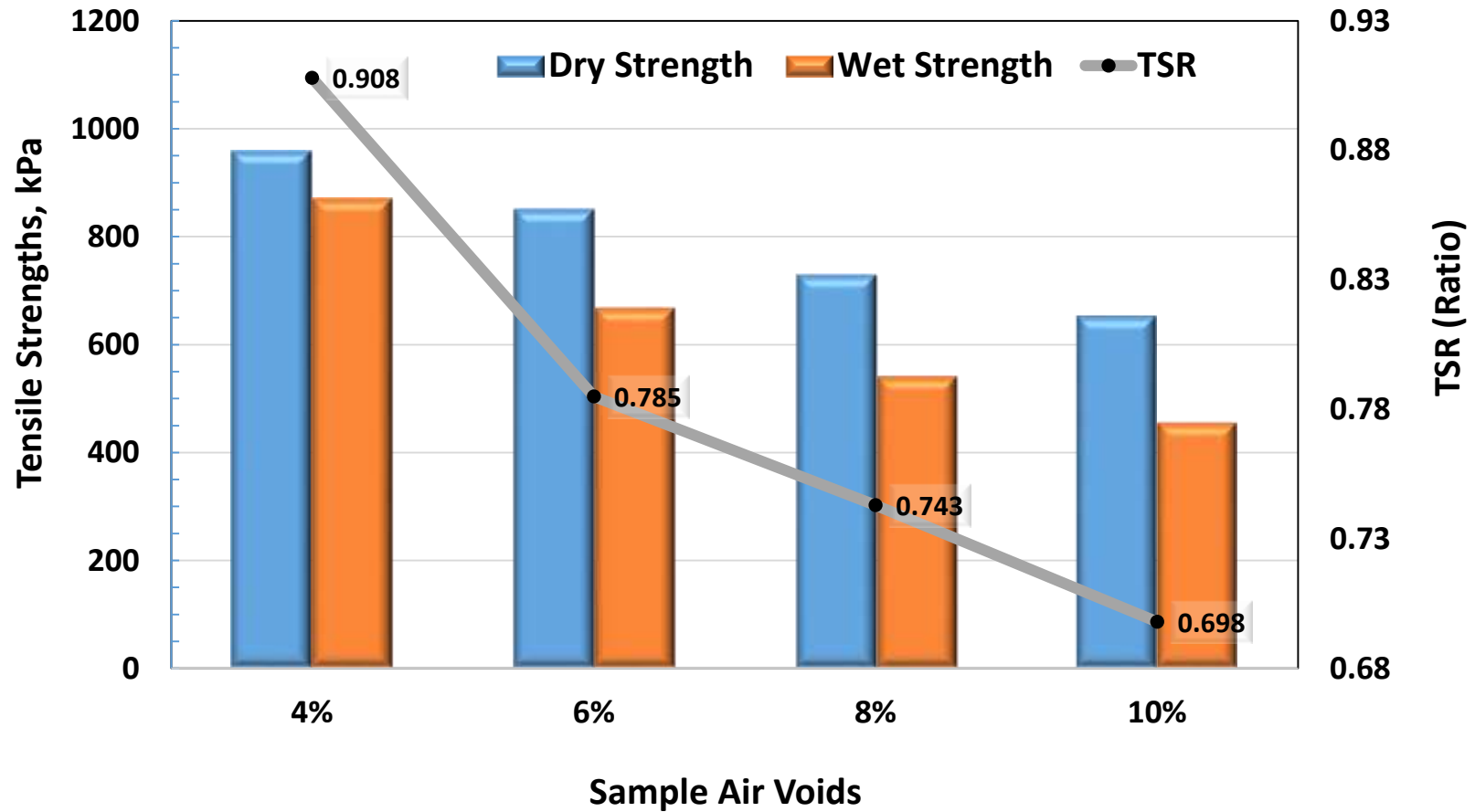
In-Place Voids vs Fatigue Life



UK-AI Study
1.5% increase
in density
leads to 10%
increase in
fatigue life.

Density impacts performance

Tensile Strength & Moisture Susceptibility vs. Air Voids
AASHTO T 283



For 9.5 mm Mixes

Critical Void Level

E. Zube - California Dept. of Highways, 1962	8.0%
L. Cooley, B. Prowell, R. Brown – NCAT, 2002	7.7%
R. Mallick, et al – NCAT, 2003 (fine graded)	8.5%

For 12.5 mm Mixes

B. Choubane, et al – Florida DOT, 1998	7%
J. Westerman – Arkansas HTD, 1998	6%
R. Mallick, et al - NCAT, 2003 (coarse graded)	7%

Multiple Research Projects Recommended Minimum of 90% TMD, or 2% Less than Required Mat Density

- “It is recommended to specify minimum compaction level at the longitudinal joint (generally 2% lower than that specified for the mat away from the joint).” NCAT / PaDOT, 2002
- “Maximum of 2% less than the corresponding mat density and minimum of 90% of TMD at the specific location.” Nevada, 2004
- “The evaluation is considered failing if the joint density is more than 3.0 pcf below the density taken at the core random sample location and the correlated joint density is less than 90%.” TTI, 2006
- “Joint density, 2% less than mat density, is achievable when measured with cores.” NCAT, 2007

1st Goal



Six-inch Cores located either directly over visible joint for butt joint, or middle of wedge for wedge joint. This gives 50/50 split of material over the two lots, so can take average the G_{mm} s.

- **$\geq 92\%$ of G_{mm} : maximum bonus**
- **Between 92% and 90% of G_{mm} : 100% pay, pro-rated bonus, need to “overband” or “surface seal” joint**
- **$< 90\%$ of G_{mm} : reduced payment, overband or surface seal L.J.**

The Pennsylvania Example

Joint Issues



PA Story on Longitudinal Joint Density

Article in NAPA's magazine, *Asphalt Pavement*, Sept/Oct 2012

<http://www.nxtbook.com/nxtbooks/naylor/NAPS0512>

- Increasing density was viewed as key
- 2007 - began measuring joint density
- 2008 - method specification of best practices
- 2008 and 2009 - continued gathering data on joints
- 2010 - New joint density specification. Transition year with no bonuses or penalties.
- 2011-2015 – bonuses and penalties on joint density

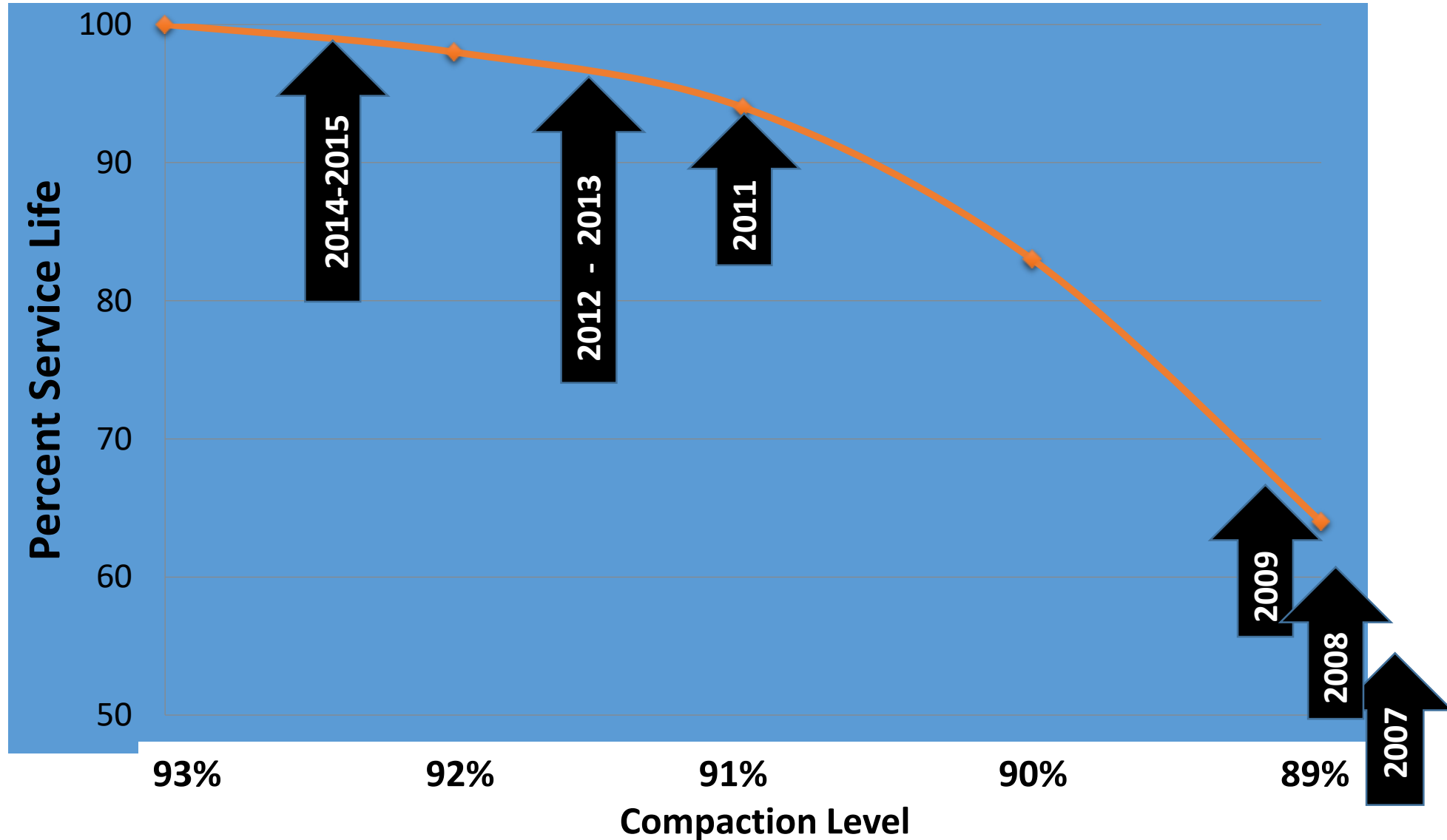
PA Joint Density Spec Highlights

- Both type of LJs allowed (butt or notch wedge)
- Joint Lot = 12,500'. Core every 2,500'. 5 cores per lot.
- Core location
 - For Butt: directly over visible joint
 - For Notch Wedge: middle of wedge
- Percent Within Limits (PWL)
 - Incentive starts at 80% PWL
 - Disincentive at <50% PWL
- Lower Specification Limit
 - 2010-2013: 89% TMD
 - 2014-2015: 90% TMD
- Corrective action for < 88% TMD

PA: How Did it Work?

In-place Density Summary, Reported by PA DOT				
Year	# Lots	Avg. Roadway Density, %TMD	Avg. Joint Density, %TMD	
2007	18	93.9	87.8	begin measuring at Jt.
2008	43	94.1	88.9	method spec
2009	29	94.1	89.2	method spec
2010	No data, transition to PWL spec			
2011	137	94.1	91.0	PWL, LSL 89%
2012	162	94.0	91.6	PWL, LSL 89%
2013	167	93.9	91.4	PWL, LSL 89%
2014	316	94.1	92.3	PWL, LSL 90%
2015	493		92.6	PWL, LSL 90%

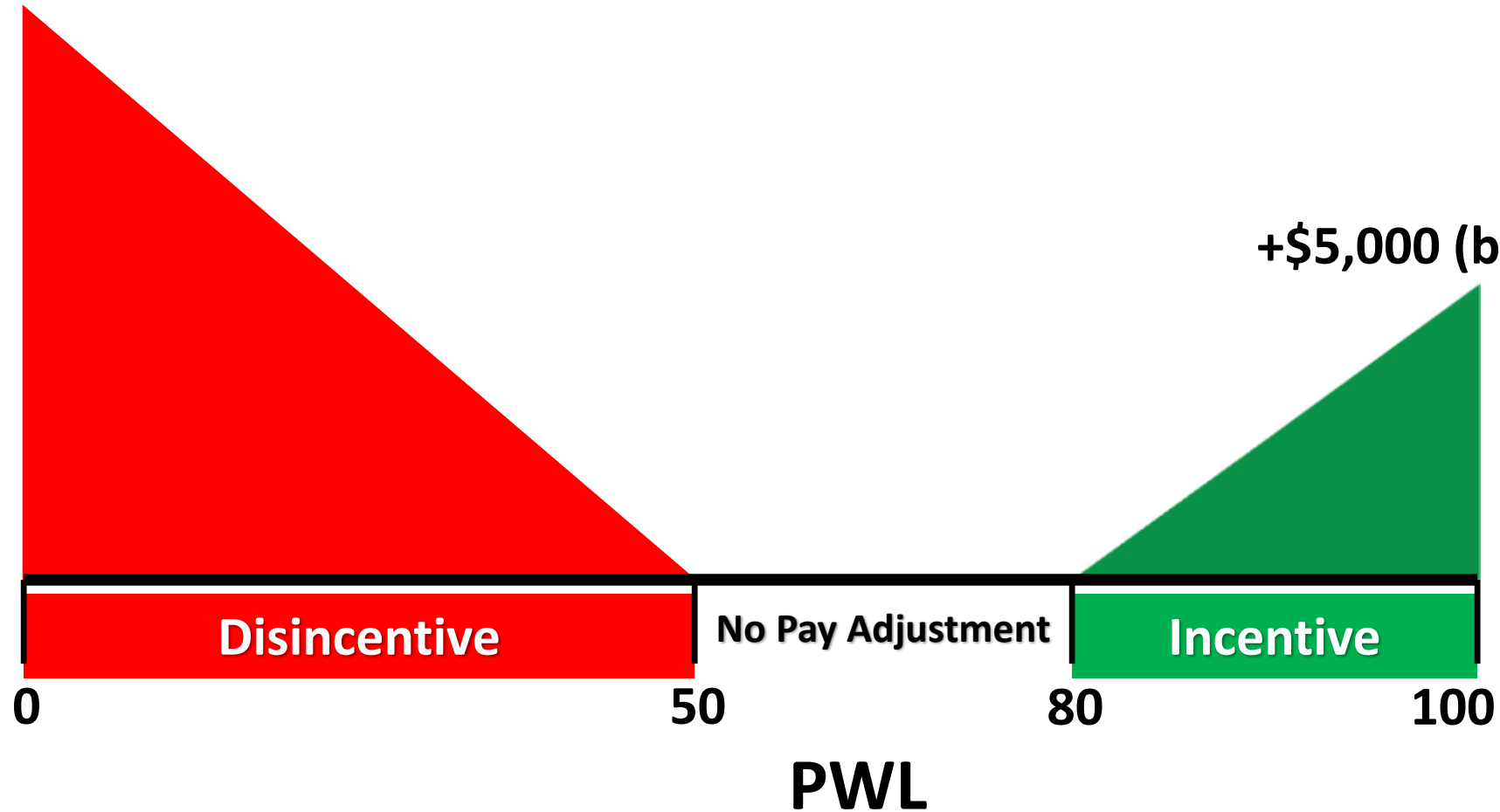
PA: Increased Projected Life of Joints Due to Improved Joint Density



Penn DOT Case Study - Impact on Lot Payment

-\$10,000 (penalty)

+\$5,000 (bonus)



PA: Annual Statewide Totals on Incentives/Disincentives for Joint Density

Year	Incentive Payments	Disincentive Payments
2011	\$268K	\$99K
2012	\$489K	\$63K
2013	\$588K	\$25K
2014	\$1,002K	\$127K



NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION

LONGITUDINAL JOINT DENSITY FOR HOT MIX ASPHALT PAVEMENTS

DESCRIPTION

This provision describes the procedure for determining core locations, coring frequency and acceptance criteria for longitudinal joint construction. This Special Provision is in addition to the requirements of Section 430, “Hot Mix Asphalt (HMA)”.

ATTACHMENTS

Appendix A – Notched Wedge

D. Coring.

Obtain joint cores at locations determined by the Engineer. The locations for joint cores will be independent of mat density cores.

Obtain density cores for butt joints centered over the longitudinal joint.

If a notched wedge style joint is constructed, center the core over the tapered portion of the joint.

E. Longitudinal Joint Field Density.

A lot for joint density is defined as the length of the joint completed in one day. Sublots are 1,000 feet in length, contained within the lot. If a day contains less than 3 sublots, that day will not be considered a lot and the sublots will be included in the next complete lot.

Sublots less than 500 feet in length will not be counted separately. Sublots 500 feet or greater in length will be considered separate sublots.

ND Specifications

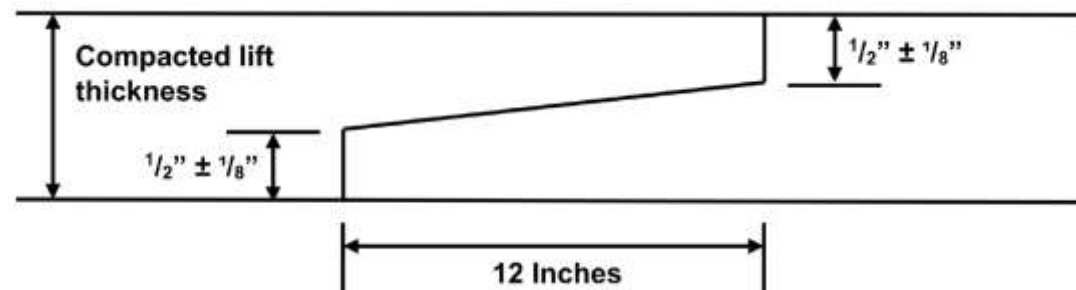
The Engineer will determine the density of each longitudinal joint core. The Engineer will then divide the joint core density by the daily Maximum Theoretical Density (MTD) calculated from the day the lot is completed.

The subplot percent MTD will then be averaged to obtain a lot percent MTD for the joint. The Engineer will use the lot percent MTD and Table 1 to determine a contract price adjustment. The Contract Price Adjustment per Linear Foot will be applied to the entire length of the lot.

Table 1

Contract Price Adjustment Per Linear Foot	Joint Lot % MTD
\$0.40	≥ 91.1%
\$0.20	90.6% – 91.0%
\$0.00	90.0% - 90.5%
\$(0.20)	89.0% - 89.9%
\$(0.60)	88.5% - 88.9%
\$(1.10)	88.0% - 88.4%
\$(1.80)	87.5% - 87.9%
\$(3.60)	87.0% - 87.4%

Appendix A Notched Wedge



ND Results



ND Mainline Density Summary

2018	92.9
2019	93.4
2020	93.4
2021	93.6
2022	93.8

2022 Avg L.J. Density

92.3

2nd Goal



Plan for Longitudinal Joints...

Discuss During Pre-Con Meeting

- Joint Type
- Layout Plan of Final Lift showing joints (DeIDOT)
 - Recognize need to offset joints between layers
 - Avoid wheel paths, RPMs, striping (if possible)
- Testing of Joint
 - Type, location, schedule, by whom
- Joint Construction Practices
 - Paving, rolling, materials
- Pave low to high when possible for *shingle effect*
 - Avoids holding rain water at joint by hot side being slightly higher (recommendation later)



Poor planning – joint in wheel path



No joints perform best

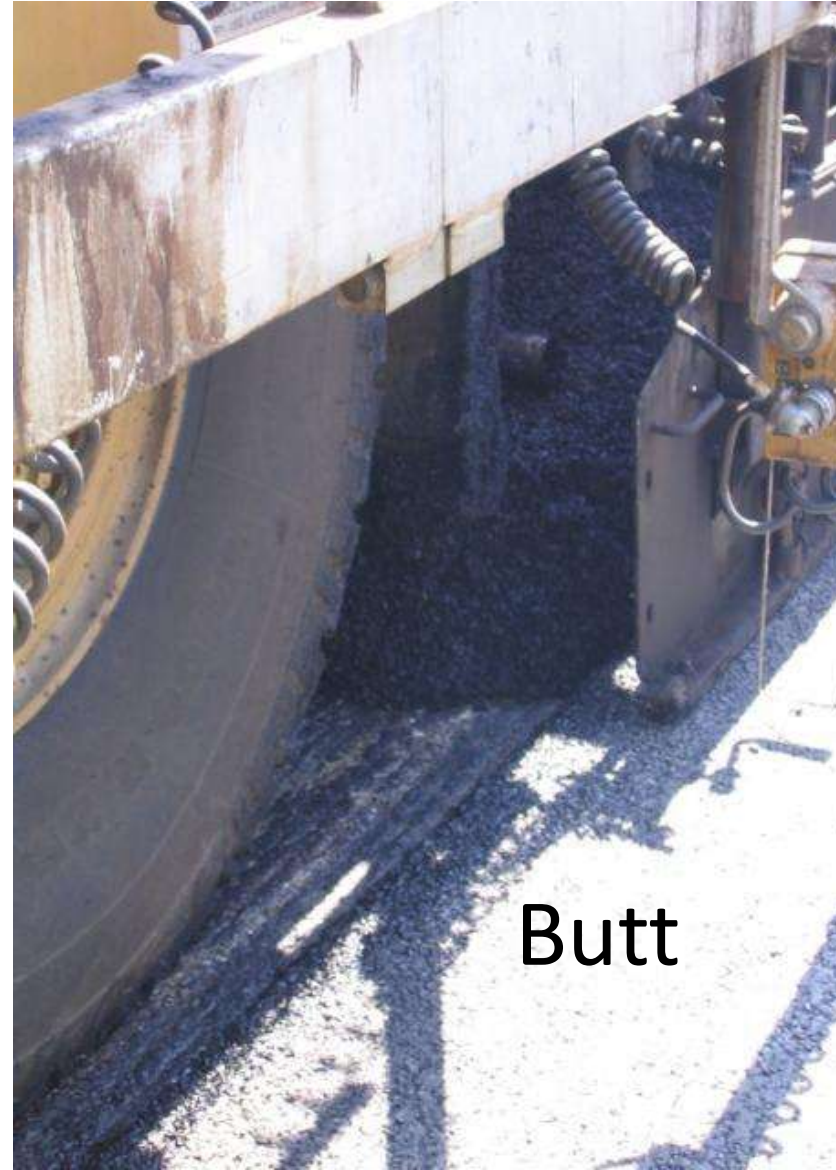


But, the need to maintain traffic limits the opportunities to pave in echelon



Preferred Joint Type? Experts Evenly Divided.

Notched
Wedge



Butt

Wedge Joints and Compaction



Vibratory
Wedge
Compactor

Average Joint Densities from PA DOT for Entire Paving Season

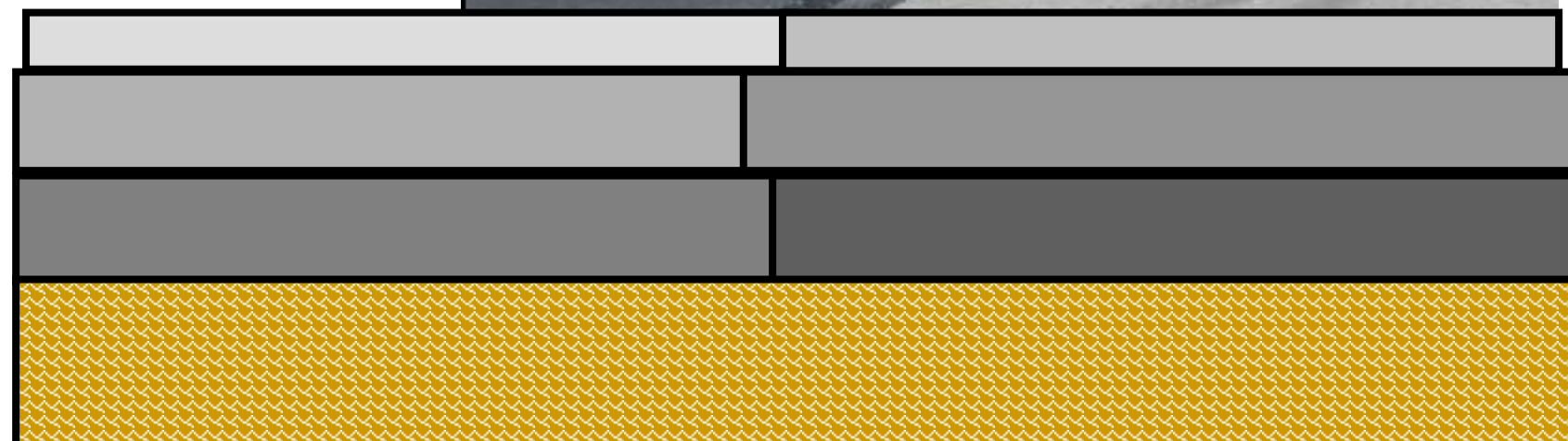
	2011	2012	2013
Notched Wedge	91.7%	91.7%	"mostly notched wedge joints"
Butt (vertical)	90.3%	90.7%	



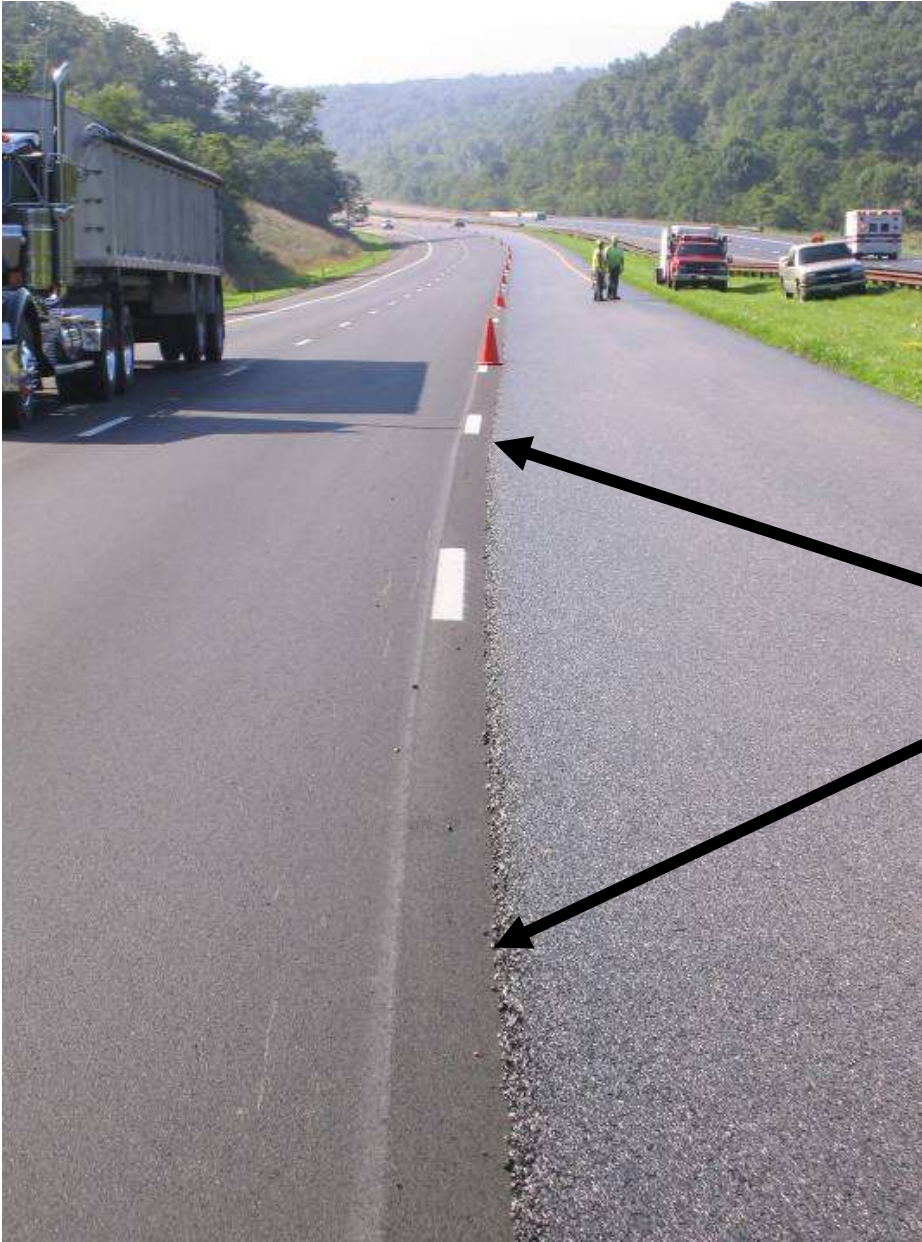
Plate Compactor

Stagger Longitudinal Construction Joints

- Offset joints between layers by at least 6-inches
- Surface joint should be near centerline (not in wheelpath)



Maryland Longitudinal Construction Joints



Great Results

First Pass Must Be Straight!

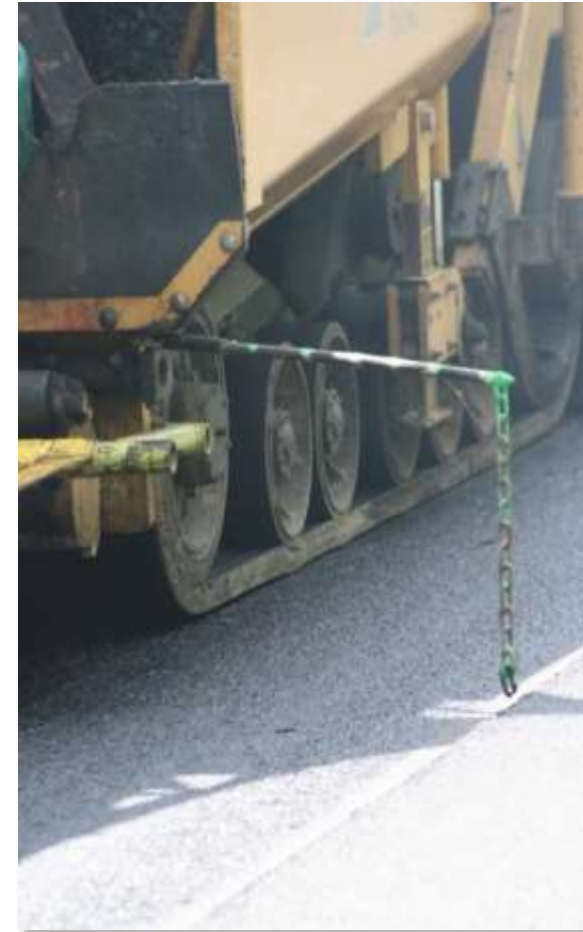
String-line should be used to assure first pass is straight



Stringline



Skip Paint



Chain Guide

Tough to get proper overlap (1") with next pass



Set Paver to Never Starve The Joint Of Material

- Target final height difference of +0.1" on hot-side versus cold side
 - NH spec requires 1/8" higher
- Joint Matcher (versus Ski) is best option to ensure placing exact amount of material needed
- If hot-side is starved, roller drum will "bridge" onto cold mat and no further densification occurs at joint



Don't starve the joint!



Proper Overlap:

- 1.0 ± 0.5 inches
- Exception:
Milled or sawed joint
should be
0.5 inches

All Photos show Bottom of Lift
(Note voids in top two from no overlap)



Core #2 (No Overlap)



Core #7 (No Overlap)



Core #9 (Overlap 1 1/2")



Core #10 (Overlap 1 1/2")

Do NOT Rake Across the Joint





Lute the Longitudinal Joint



This lute person is
doing a great job

Question – Use a Ski or Joint Matcher?

Ski Best for Smoothness
(reference is average over length of ski)



Versus Joint Matcher,
which is best for joint
(reference is exact location
just in front of auger)

Note: If underlying
pavement already smooth,
some contractors feel they
can get good joint with ski,
but must finish 1/10" high

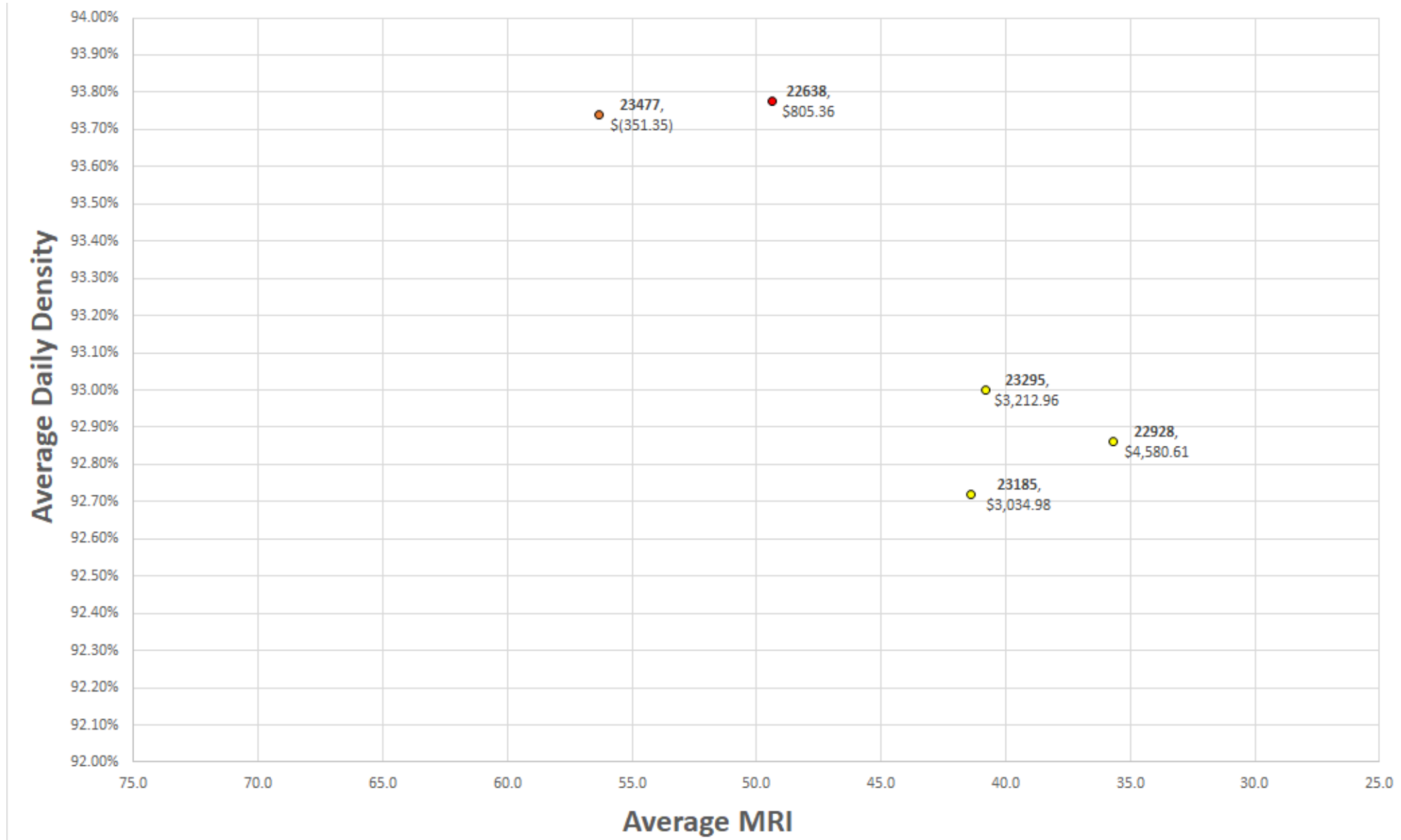
Does your first pass ever over run?



Destined for Failure

Likely that the hot side of joint was starved of material at these locations and bridging occurred.

HMA Density vs Ride



Questions ?

GLOBAL MEMBERS



REGULAR MEMBERS



ASSOCIATE MEMBERS



CANADIAN MEMBERS



INTERNATIONAL MEMBERS



COMMERCIAL MEMBERS



AFFILIATE MEMBERS

